

APPENDIX A

EXCERPT FROM SPECIFICATION

[0079] In one example, a heated target facilitates sputter deposition of a **gold cadmium** shape memory alloy film. One advantage of a AuCd over nickel titanium is that the AuCd system is much less sensitive to contaminants such as oxygen, water vapor and nitrogen. Thus, the **base pressure may be greater than  $10^{-8}$  Torr**, the **distance between the target of a substrate for two-way shape memory effect actuator grade material may be up to 6 inches** and a two-way shape memory effect **film may be thicker** than a comparable film for nickel titanium. For example, **AuCd may be alloyed with an additional element** to form a ternary shape memory alloy, using hydrogen, copper, silver, zinc or mercury as the third alloying element. Alternatively, higher order alloys may comprise more than one of the elements. The **target temperature during deposition is selected in a range from 150.degree. C. to 400.degree. C.** and the **substrate temperature is maintained between one-third and two-thirds of the alloy melting temperature**, for example. The melting temperature for AuCd-based ternary alloys ranges from about 190.degree. C. to 400.degree. C. Preferably, the **vacuum pressure during sputter deposition is selected in a range from  $9 \times 10^{-4}$  Torr to  $1 \times 10^{-2}$  Torr** by adding an inert gas. The rate of deposition increases as the amount inert gas increases. The limited reactivity of Au and Cd to contaminants such as oxygen, water and nitrogen allows a **comparatively high vacuum base pressure during purging of the contaminants**, which may be selected at a vacuum pressure **no greater than  $10^{-3}$  Torr**. For example, a range from  $10^{-6}$  Torr to  $10^{-3}$  Torr is preferred for the base pressure during purging prior to introduction of the inert gas. By limiting the base pressure to  $10^{-6}$  Torr, the design of the enclosure is greatly simplified compared to ultra high vacuum system required for Ni:Ti SMA. This allows commercial production of much larger devices.

[0080] In another example, the shape memory alloy is selected from an **iron manganese silicon quaternary or higher order alloy** wherein additional alloying elements are selected from hydrogen, boron, carbon, magnesium, aluminum, silicon, phosphorous, sulfur, calcium, scandium, titanium, vanadium, chromium, columbium, nickel, copper, zinc, selenium, strontium, yttrium, zirconium, niobium, molybdenum, ruthenium, rhodium, palladium, silver, cadmium, tin, antimony, tellurium, barium, lanthanum, hafnium, tantalum, tungsten, rhenium, osmium, iridium, platinum, gold, lead, bismuth, polonium, cerium, praseodymium,

neodymium, samarium, europium, gadolinium, terbium, ytterbium, lutetium, thorium, protactinium, and uranium. The **target temperature** is selected to be at least 770° C., and the **process temperature of the substrate** is selected to be in a range from about one-third to two-thirds of the melting temperature of the quaternary or higher order alloy composition, for example. The melting temperature for the alloys considered here ranges from about 1,100.degree. C. to 1,400.degree. C. The vacuum pressures during processing are selected in a range from  $9 \times 10^{-4}$  Torr to  $10^{-2}$  Torr and an inert gas is used to generate a plasma. Iron, manganese and silicon have limited reactivity to the typical contaminants such as oxygen, water and nitrogen. For actuator grade material having a two-way shape memory effect, the base pressure during purging should be selected at a pressure no greater than  $10^{-5}$  Torr.

[0081] In yet another example, the shape memory alloy is based on one of copper zinc aluminum and copper nickel aluminum. Specifically, ternary, quaternary and higher alloys are used including hydrogen, boron, carbon, magnesium, aluminum, silicon, phosphorous, sulfur, calcium, scandium, titanium, vanadium, chromium, columbium, nickel, copper, zinc, selenium, strontium, yttrium, zirconium, niobium, molybdenum, ruthenium, rhodium, palladium, silver, cadmium, tin, antimony, tellurium, barium, lanthanum, hafnium, tantalum, tungsten, rhenium, osmium, iridium, platinum, gold, lead, bismuth, polonium, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, ytterbium, lutetium, thorium, protactinium, and uranium. For example, the **target temperature** is selected in a range from at least 350° C. The **process temperature of the substrate** is maintained in a range from about 190° C. to 400° C., for example. The vacuum pressure during processing is selected to be in a range from  $9 \times 10^{-4}$  Torr to  $10^{-2}$  Torr, using an inert gas to generate a plasma. In this example, the element aluminum is even more reactive than titanium to some of the typical contaminants such as oxygen, water and nitrogen; however, the degree of sensitivity of the transition temperatures and other material properties of the shape memory alloy are substantially less than for titanium in Ni:Ti SMA. Thus, a base pressure

during purging of contaminants may be selected that is **no greater than  $10^{-6}$  Torr** for actuator grade, two-way shape memory alloys.

The Applicant respectfully requests that the amendments to the claims be entered. All of the claims are now in condition for allowance.

I hereby certify that this correspondence is being facsimile transmitted to the USPTO, Examiner John J. Zimmerman, Group Art Unit 1775, (571)273-8300 on the date indicated below

Christopher Paradies

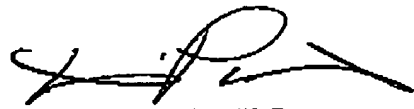
Name of applicant, assignee or  
Registered Representative

  
Signature

November 21, 2005

Date of Signature

Respectfully submitted,

  
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Enclosure

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